TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. FHWA/NC/2006-55	2. Government Accession No. … …	3. Recipient's Catalog No. … …
4. Title and Subtitle Real World Duty Cycles and Utilization for Construction Equipment in NC		5. Report Date January 4, 2008
		6. Performing Organization Code … …
7. Author(s) Dr. H. Christopher Frey, Dr. William J. Rasdorf, Kangwook Kim, Shih-Hao Pang, Phil Lewis , Saeed Abolhassani		8. Performing Organization Report No. … …
9. Performing Organization Name and Address North Carolina State University Department of Civil, Construction and Environmental Engineering Campus Box 7908 Raleigh, NC 27695		10. Work Unit No. (TRAIS) … …
		11. Contract or Grant No. … …
12. Sponsoring Agency Name and Address North Carolina Department of Transportation Research Unit 104 Fayetteville Street Raleigh, North Carolina 27601		13. Type of Report and Period Covered Final Report July 2005 to June 2007
		14. Sponsoring Agency Code 2006-08
Supplementary Notes: … …		

16. Abstract

Field data for in-use fuel consumption and emission rates were collected for 15 nonroad vehicles using a portable emission measurement system (PEMS). Each vehicle, including 5 backhoes, 4 front end loaders, and 6 motor graders, were tested once on petroleum diesel and once on B20 biodiesel. The vehicles included different model years and thus represent a variety of engine certification tiers. A methodology was developed for study design, field data collection, data screening and quality assurance, data analysis, and benchmarking of the data. The average rate of loss of data due to data quality issues was 6.9%. On average, over 3 hours of valid data were collected in each test. Time-based emission factors were found to increase monotonically with respect to engine manifold absolute pressure. Fuel-based emission factors were mainly sensitive to differences between idle and non-idle engine operation. Typical duty cycles were quantified in terms of frequency distributions of manifold absolute pressure (MAP) and used to estimate cycle average emission factors. On average, the use of B20 instead of petroleum diesel lead to an insignificant 1.8% decrease in NO emission rate and significant decreases of 18, 26, and 25% for opacity, HC, and CO, respectively. Emission rates were also found to decrease significantly when comparing newer, higher tier vehicles to lower ones. Fuel use rate, and NO, HC, and CO emission factors, were found to be of similar magnitude as independent benchmark data. An emissions inventory was developed for these vehicles. The current fuel mix of B20 and petroleum diesel is estimated to produce 0.4 to 6.4 percent lower emissions, depending on the pollutant, than usage of 100 percent petroleum diesel. If NCDOT were to use 100% B20 in the same vehicles, then additional reductions in emissions of each pollutant would be approximately 2.0% to 36.9% lower than for the current fuel mix of B20 and petroleum diesel. Although higher tier engines have lower emissions factors for each pollutant than lower tier engines, their annual average emissions tend to be higher because of greater utilization. Specific recommendations are made for future work, including expansion of the use of B20 to further reduce tailpipe emissions in the NCDOT inventory, replacement of older vehicles with newer ones, field data for larger sample sizes of vehicles for each Tier in order to improve confidence in the emissions factors and inventories, assessment of Tier 4 vehicles as they become available using improved instrumentation, evaluation of fuel formulations, evaluations of other vehicle types, and others.

17. Key Words construction vehicles, construction equipment, backhoes, front-end loaders, motor graders, diesel engines, air pollution, emissions, duty cycles, PEMS	18. Distribution Statement … …		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 516	22. Price … …

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